THE WEATHER AND CIRCULATION OF JANUARY 1959

A MONTH OF EXCEPTIONAL PERSISTENCE FROM THE PRECEDING DECEMBER

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1. PERSISTENCE FROM DECEMBER 1958 TO JANUARY 1959

WEATHER ANOMALIES

Very high persistence over North America from December to January was one of the outstanding facets of the monthly mean weather and circulation of January 1959. One should anticipate a normal increase in month-to-month persistence of temperature, mean 700-mb. heights, and to a lesser degree, precipitation in passing from fall into winter [1]. However, stability of pattern and weather anomalies from December to January was so great this year that special emphasis is warranted.

Class changes of monthly mean temperature in the United States are shown in table 1. These data were derived from an array of 100 well-distributed stations and represent changes in classes based on the normal distribution of temperature at each city. The classes much above and much below normally occur 12½ percent of the time each, and above, normal, and below normally occur 25 percent of the time each. On examining the table, one is first struck by the absence of any change exceeding two classes. But even more significant, and certainly more indicative of the month's persistence, is the fact that 96 percent of the stations did not change by more than one class.

It is interesting to compare the results in table 1 with the averages determined by Namias [1] for the period 1942–1954. In his study the average number of 0+1 class changes (no change or a change of one class) for December to January was 71 percent. By comparison, January 1959 with 96 percent was phenomenally static. Fairly high persistence has been found in other Januarys (e.g., 1956 [2]), but in the last 17 years there has not been a January with smaller temperature changes than this year. Parenthetically, it should be noted that 0+1 class temperature persistence greater than 90 percent has been observed only 17 times since April 1942 (8 percent of the time).

TABLE 1.—*Class changes of weather anomalies in the United States from December 1958 to January 1959*

Class Change	Frequency (percent)
Temperature	
0	54
1	42
2	4
3	0
4	0
Precipitation	
0	47
1	35
2	18

Precipitation from December 1958 to January 1959 was also quite persistent. Table 1 shows a 47 percent value of the 0 class change in precipitation for January. This represents rather high stability when compared to the December-January average of 37 percent for the years 1942–1954 [1]. In fact, there were only three previous Januarys in the past 17 years in which the 0 class change of precipitation was greater than the 47 percent of 1959.

It is difficult to make direct comparison of persistence of precipitation with that of temperature since values are computed for 0 class change for the former and 0+1 class change for the latter. However, the two can be compared by expressing them in terms of their long-period average. For example, this month's persistence of precipitation was 127 percent of the 13-year average value, while the corresponding figure for temperature was 135 percent.

CIRCULATION

Persistence of the 700-mb. pattern was as pronounced as that of the weather anomalies. A qualitative comparison of the 30-day mean 700-mb. chart for January 1959 (fig. 1) with that of December 1958 (fig. 1 of [3]) shows a ridge in western North America, a trough along the east coast, and a Low in Canada. Height departures from normal in the same figures show a remarkable similarity.

A quantitative evaluation of circulation persistence can be expressed in terms of a lag correlation between the patterns of height anomalies. This was done earlier [1] for the period 1933–1950, using a grid extending from 30° to 50° N. and from 70° to 130° W. An average lag correlation of +0.36 was obtained for all December to January periods. A similar correlation computed for Decem-

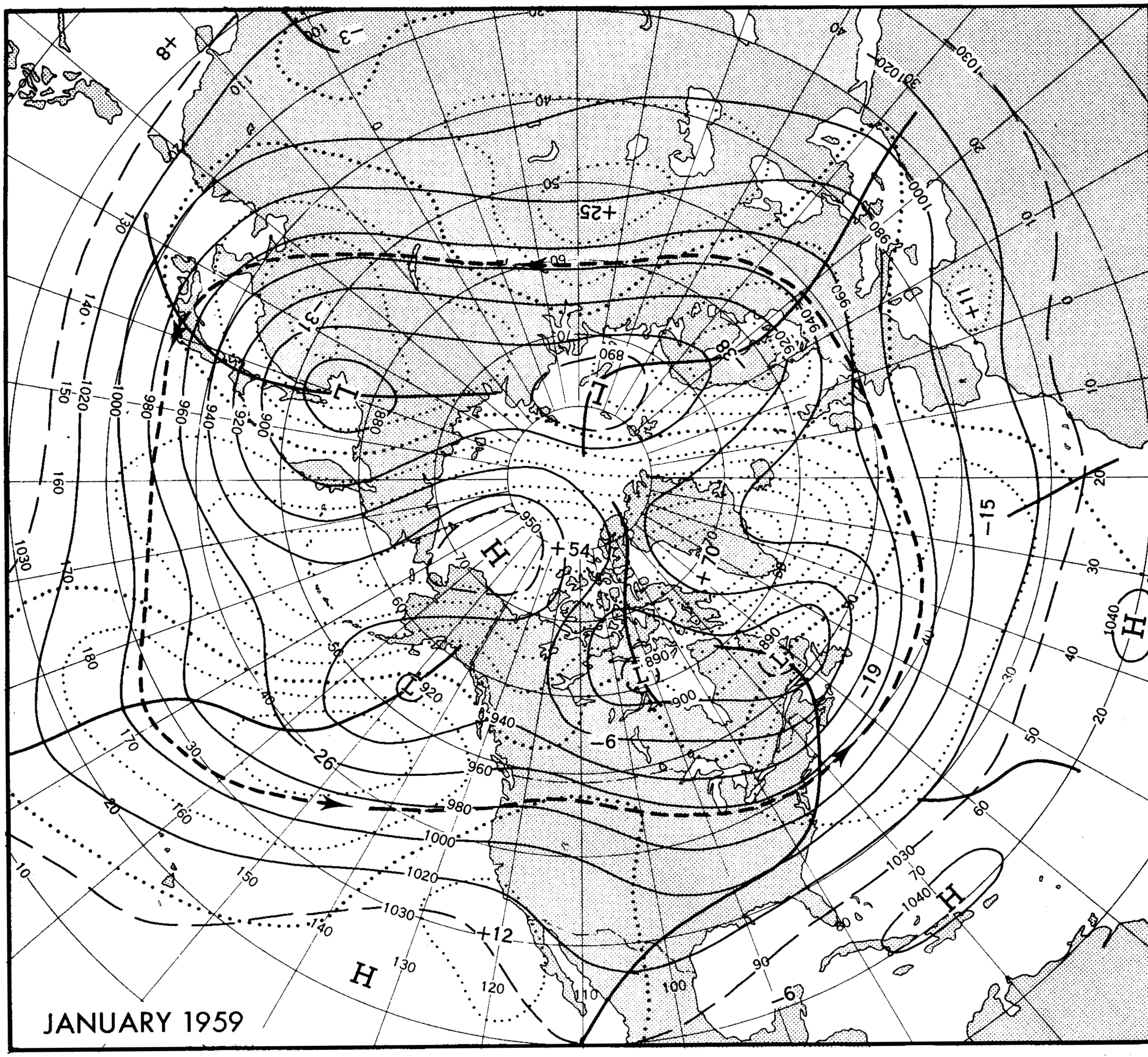

FIGURE 1.—Mean 700-mb. contours (solid) and height departures from normal (dotted) (both in tens of feet) for January 1959. Heavy dashed arrows represent the axis of the mean 700-mb. wind maximum. Widespread positive height departures over the polar region reflected intense blocking there.

ber 1958 to January 1959 was +0.61, substantially greater than the average for the 18-year period above.

There was one feature of the circulation not wholly consistent with the high persistence. A marked change occurred in the strength of the 700-mb. temperate westerlies (35°–55° N., computed twice monthly for overlapping 30-day periods). The zonal index for the western half of the Northern Hemisphere for December was 12 m.p.s., 0.7 m.p.s. above normal. During January the index decreased to 9.9 m.p.s., 1.9 m.p.s. below normal. This is the first month in the last nine in which the temperate index averaged below normal. The value of the 30-day mean sea level index in temperate latitudes averaged 1.6 m.p.s. below normal, following a near normal index in December. The configuration of systems typical of low index can be seen on the 30-day mean sea level chart (fig. 2). These features include split Aleutian and Icelandic Lows, strong polar Highs, and weak subtropical Highs.

2. MAJOR FEATURES OF THE NORTHERN HEMISPHERE CIRCULATION

The hemispheric circulation in January 1959 (fig. 1) consisted of a wave number of four in middle latitudes.

The troughs at higher latitudes in the western half of the Northern Hemisphere were rather weak compared with those of the eastern half. This is shown by the relative intensity of the 700-mb. 30-day mean height departures from normal. The troughs near North America were less intense and did not penetrate as far northward as did those of Europe and Asia.

The circulation in midtroposphere in far northern latitudes of the Western Hemisphere was much more anticyclonic than that which normally prevails [4]. The large High over the Beaufort Sea was an especially significant center of action in influencing weather in the United States. It was part of a very extensive band of positive height anomalies which blanketed the area from the Bering Sea to Denmark Strait with heights ranging from 400 to 700 feet above normal. The unusual circulation in that region, which included anomalous centers of the greatest absolute magnitude in figure 1 and which dominated the flow in the Northern Hemisphere, was also conspicuous in the weather and circulation regime of December. In fact, high-latitude blocking over North America has been a circulation feature of varying magnitude in each month since June 1958.

A fairly well-developed Low in the Gulf of Alaska and its attendant trough south-southwestward maintained the approximate intensity observed in December (fig. 1 of [3]), but important changes occurred. The trough acquired a positive tilt as the lower portion retrograded some 25° from its December position. As the trough along the coast of Asia deepened, the wavelength in the Pacific shortened. The fast westerlies observed in mid-Pacific in December were replaced by a difluent zone near the International Date Line, and the mean 700-mb. wind speed maximum (shown by a dashed arrow in fig. 1) was displaced 10° southward in January from its position near 37° N. in December (see fig. 3A of [3]).

Though the ridge-trough couplet over the United States and Canada appears to have been of small amplitude, the flow was vigorous enough to keep the West warm and the rest of the United States quite cold (fig. 3). The 30-day mean 700–1000-mb. thickness anomaly field (fig. 4) shows the extent of the cold air and its extremely cold pool over northern British Columbia. The channel of cold air from northwestern Canada to Tennessee was practically coincident with a strong ridge of high pressure at sea level (fig. 2) and with the path of maximum anticyclonic activity, illustrated in figure 2 as a heavy dashed arrow. (See also tracks of centers of anticyclones at sea level, Chart IX, of [5].)

The ridge over Greenland, principally a development of the first half of the month, was closely associated with the strength of the trough in Europe. The westerly flow into central Europe met the northwesterly flow from the Arctic in a zone of strong confluence, and cold air was thus contained north of 50° N. in the mean (see fig. 4).

Strong westerlies across northern Asia, with the axis of the mean 700-mb. wind speed maximum reaching 60° N.

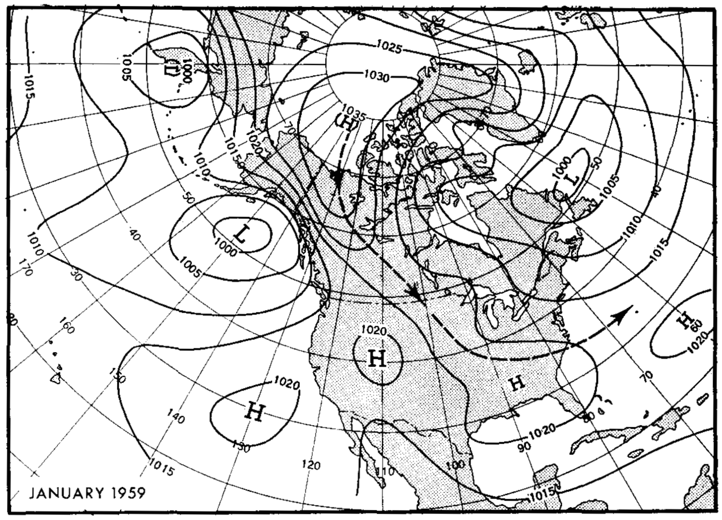

FIGURE 2.—Mean sea level isobars (in millibars) for January 1959. Heavy dashed arrows represent the main anticyclone track in January. The prominent ridge from the Arctic Ocean to the Gulf of Mexico shows the southward drive of cold air.

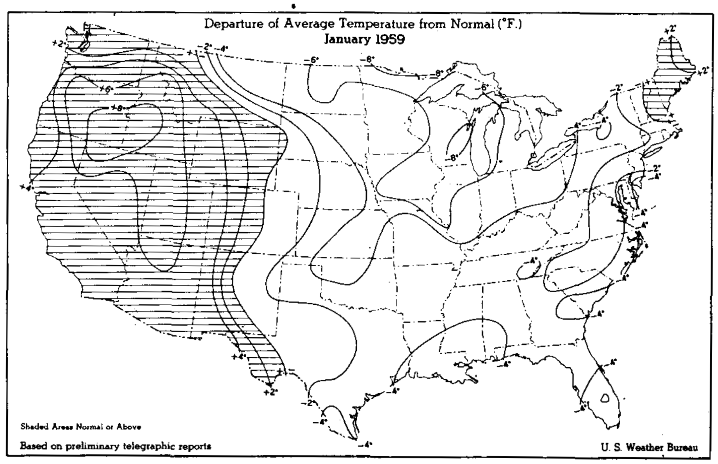

FIGURE 3.—Departure of average temperature from normal (° F.), January 1959. Hatching indicates areas of normal or above normal temperatures. The barrier effect of the Rockies is well shown as cold air stayed east of Divide.

(fig. 1), accommodated the long wavelength downstream to the next trough in eastern Asia. Adequate cold air supported the strong, full-latitude trough observed in that area, which is also a zone of high trough frequency climatologically [6].

3. VARIABILITY IN THE WESTERN HEMISPHERE DURING JANUARY

Since the 30-day mean smooths shorter-term variations in the pattern, a breakdown of the mean into 15-day components is of some interest. It has been noted above that the January pattern closely resembled that of the preceding month. One might thereby reasonably expect persistence within the month. But a comparison of the circulation of the first and last halves of the month (figs. 5 and 6) reveals rather sudden changes.

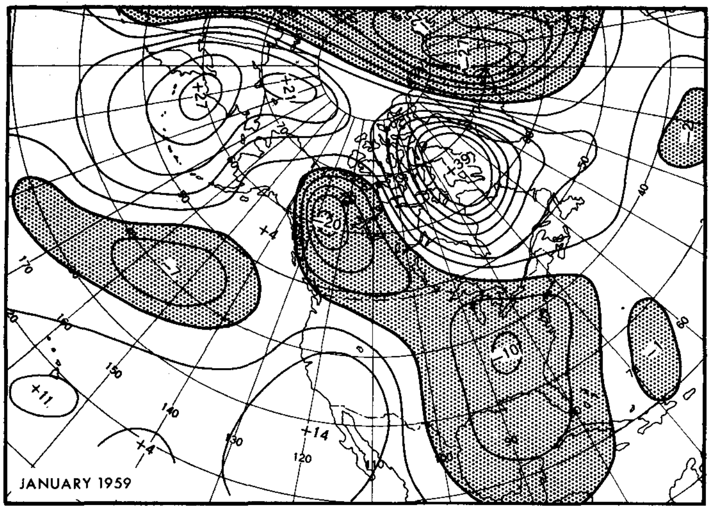

FIGURE 4.—Mean thickness (1000–700 mb.) departures from normal (tens of feet) for January 1959. Below normal thickness areas (shaded) were almost identical to areas of below normal surface temperature (fig. 3).

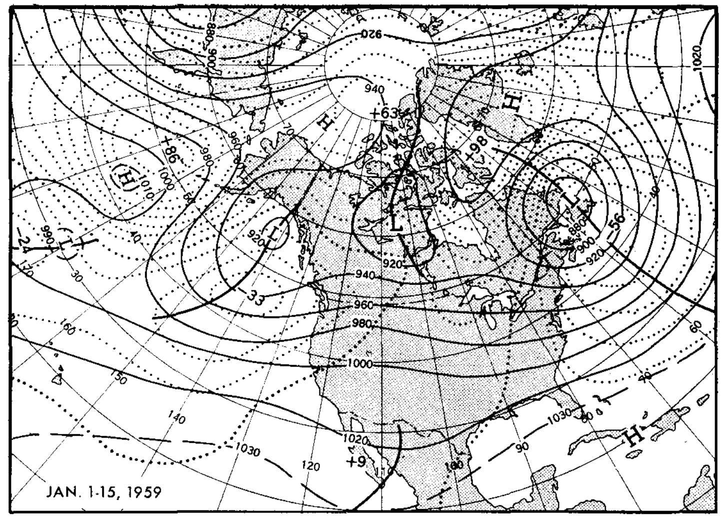

FIGURE 5.—Mean 700-mb. contours (solid) and height departures from normal (dotted) (both in tens of feet) for January 1–15, 1959. Fast westerlies and a long half wavelength dominated the United States.

A downstream transfer of westerly momentum from the coastal trough near Asia assisted in the erosion of the subtropical ridge in the mid-Pacific, where heights fell as much as 1000 feet (fig. 7). This allowed retrogression of the trough in the Gulf of Alaska (fig. 6), where heights increased over 300 feet, and its consolidation with the Kona trough west of Hawaii.

The moderately long wavelength between the trough in the eastern Pacific and that in the western Atlantic was supported during the first half of January by rather strong westerlies. But the half-wavelength downstream from the ridge along the west coast was considerably longer than that usually observed, a condition which usually precedes a circulation change of major proportions. The vigorous new trough over the Mississippi Valley in the succeeding half-month (fig. 6) is an excellent example of a new mean trough development as described by Namias [7] and apparently was associated with:

a. A wavelength too long to be supported by the speed of the westerlies.

b. Retrogression of the ridge in western North America and its intensification as it amalgamated with the Arctic Basin High.

c. Strengthening of the trough in central Canada.

d. Northeastward extension of the trough in Mexico.

This classical development of a new trough is also a prime example of amplification of the contour pattern. The intensity of the change from figure 5 to figure 6 is depicted in figure 7, the change in height anomaly from the first to the last half of January. Meanwhile the trough in the western Atlantic was swept eastward to the Azores, where heights decreased over 400 feet. South of Newfoundland height increases exceeded 700 feet as a strong ridge replaced the trough.

Temperature anomalies for each half of the month, as seen in figure 8 A and B, appear very much alike in spite of differences in circulation. However, an examination of figure 8C shows significant changes related to the evolving circulation. Note especially the negative anomalous temperature change in figure 8C and compare it with the height change in figure 7. Positive height anomalies of January 1–15 were replaced by negative anomalies of January 16–30 from Hudson Bay to the Gulf of Mexico and from the Continental Divide to the Ohio Valley. At the same time, temperature anomalies became more negative in the Plains and Central States as far south as Arkansas. Maximum changes of 10° F. were reported near the Canadian border. Partially as a result of the new trough development, temperatures increased in the South, the Northwest, and the East. An increase of 6° F. occurred in Virginia in advance of the trough.

The decreases of temperature in the Far West are more puzzling. An increase in 700-mb. height anomaly (fig. 7) does not usually imply a decrease in temperature. Many factors could contribute to a cooling, but perhaps most important in this case was the direction of anomalous flow, which changed from southwest the first half of the month to northwest the last 15 days, as the ridge retrograded from the Rocky Mountains to the west coast. However, even though there was considerable intramonthly cooling, mean temperatures were still above normal in the Far West and Southwest for the period January 16–30.

4. WEATHER IN THE UNITED STATES RELATED TO CIRCULATION

TEMPERATURE

Several injections of Arctic air into the United States east of the Divide produced a cold regime in the East.

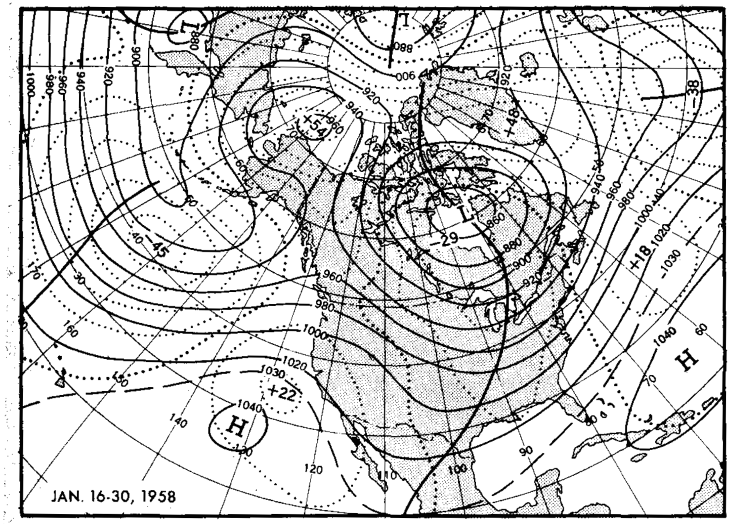

FIGURE 6.—Mean 700-mb. contours (solid) and height departures from normal (dotted) (both in tens of feet) for January 16–30, 1959. Note new trough which formed in central United States as the ridge in the West retrograded and the trough in the western Atlantic progressed.

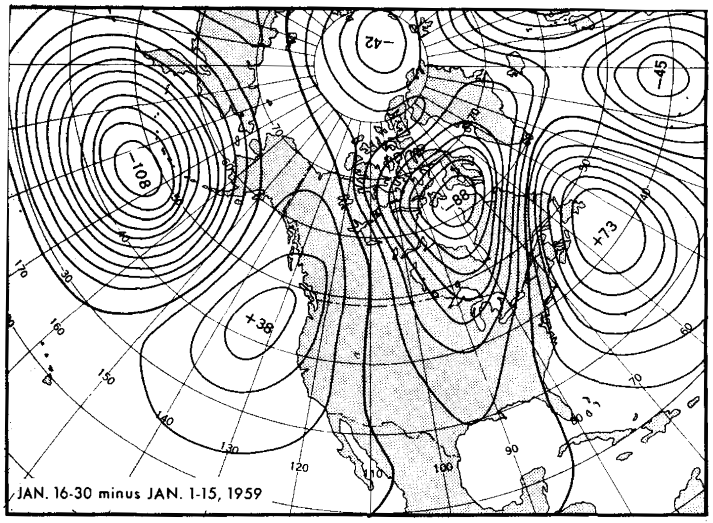

FIGURE 7.—Change of mean 700-mb. height departure from normal (tens of feet) from January 1–15 to January 16–30, 1959. This pattern accompanied considerable amplification of the long waves.

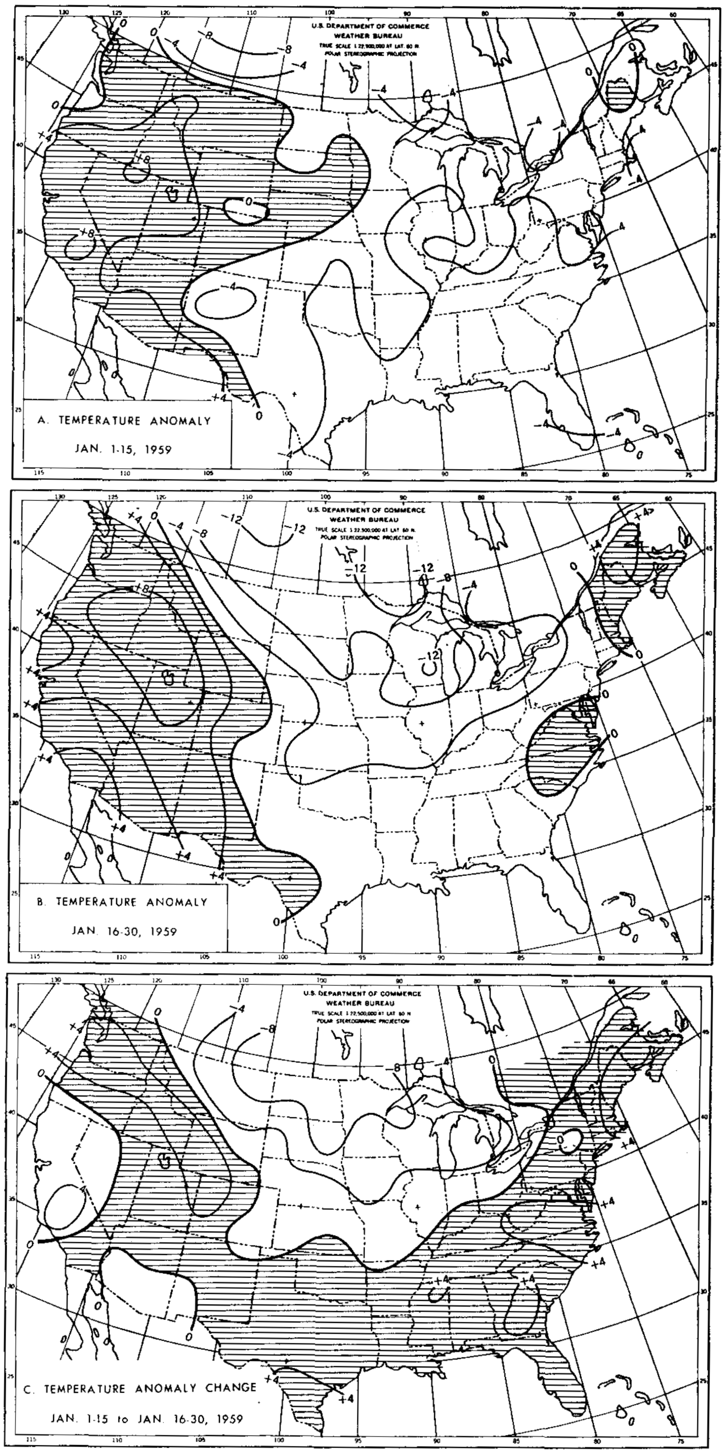

FIGURE 8.—Temperature departure from normal (° F.) for (A) January 1–15, 1959, (B) January 16–31, 1959. Shaded areas are normal or above. In (A) warming east of Divide in Plains States was related to foehn action. In (B) note cooling in North Central and Northern Plains States. (C) Change in temperature departure from normal (° F.) from January 1–15 to January 16–31, 1959. Shaded areas represent positive changes (warming). (From [8].)

This, together with warming in the West, resulted in a distribution of temperature which was meridional, a situation generally associated with great temperature extremes. In this month, for example, the warmest January of record was observed at Los Angeles and San Francisco, while Muskegon, Mich. and International Falls, Minn. were having the coldest (and snowiest at Muskegon) January of all time.[1]

Extreme cold early in January accompanied a front which dropped daily temperatures as much as 50° and was responsible for a weekly average temperature of 20° below normal at Amarillo, Tex. [8]. As cold air spread to the east coast, warming occurred throughout the West. An example of the magnitude of that change was recorded

[1] From *Local Climatological Data* report of each city, January 1959.

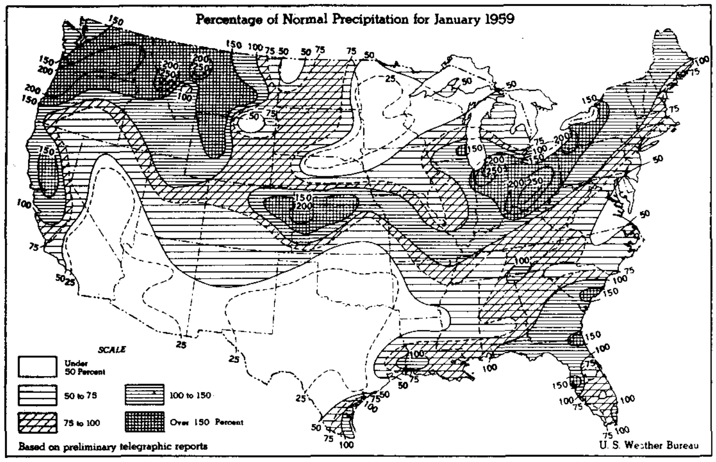

FIGURE 9.—Percentage of normal precipitation for January 1959. Heaviest amounts were found near the mean 700-mb. wind maximum and cyclone track. (From [8].)

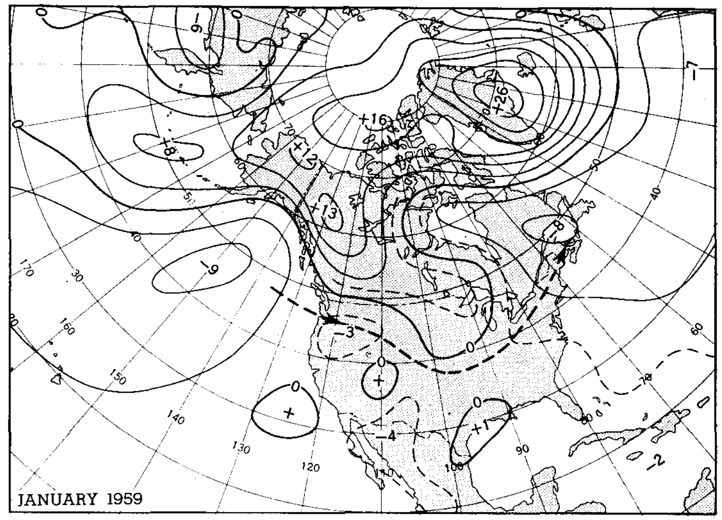

FIGURE 10.—Mean sea level pressure departure from normal (millibars) and principal cyclone track (heavy dashed arrows). There was a close correspondence between the position of the storm track, the mean 700-mb. wind maximum, and area of heavy precipitation.

at Great Falls, Mont. where a minimum temperature of —29° on January 3 was followed by a maximum of 62° on the 12th.[1] By midmonth, warming progressed to the Plains States, while the Eastern States had become quite cold. During the week ending January 25, cold air again plunged to the Southern Plains States, following a fast-moving storm which became well organized in New Mexico on January 20. Average temperatures in Oklahoma, which were 6° above normal the preceding week, dropped to 6° below normal, and Birmingham, Ala. recorded a 52° decrease in temperature in 18 hours on the 21st. The reverse change in temperature was reported in the East from the Carolinas northward and resulted in a spectacular January thaw in the manner described by Wahl [9].

January was not especially noteworthy regarding temperature records, but there were additional features of interest. A comparison of figures 3 and 4 shows that the isopleth of 0° temperature departure from normal is almost identical with the zero isopleth of the average thickness DN. One also sees that below normal thicknesses almost everywhere match below normal temperatures. It should also be noted that the height anomalies of figure 1 have a similar relationship to the temperature, although less well defined.

The 30-day mean of sea level pressure (fig. 2) also helps explain the temperature distribution of figure 3. The ridge from the Beaufort Sea to Florida and the flow from the District of Mackenzie to the Atlantic Coast States defines the source of cold air and its transport southeastward. The warm High over the Great Basin and the onshore flow into the West are indicative of the above normal temperatures observed there. It is of some historical significance that California coastal areas have escaped the below normal category since early April 1958, except for two consecutive 5-day periods in mid-November.

PRECIPITATION

Total precipitation accumulation in the United States, in terms of percentage of monthly normal, are shown in figure 9. The most prominent feature is the band of above normal precipitation which extended from the Pacific Northwest (where Spokane had its wettest January), across Kansas, through the Ohio Valley, and into New England. Disastrous flooding occurred in Ohio, western New York (where Buffalo had its wettest January), western Pennsylvania, and along the Wabash River system in Indiana. Rainfall of record proportions and melting snow associated with the storm of January 20–23 were responsible for the flood loss of many lives and property loss of millions of dollars.

It is generally harder to relate precipitation to the observed circulation or its anomalous flow than temperature. In this January, however, the task is relatively simple. In figure 10, the 30-day mean sea level pressure departures, one can see a corridor of negative values which closely resembles the configuration of the area of heavy precipitation. This was related to the principal storm track during January, represented by the heavy dashed arrow. The storm track is based on an analysis of frequencies of cyclones in a grid of equal area boxes and on inspection of tracks of daily centers of cyclones at sea level (Chart X of [5]). Note also the proximity of the 700-mb. mean wind speed maximum (in fig. 1) to the cyclone track and axis of heavy precipitation. Compared with normal tracks and mean frequencies of cyclones [10], those in January were displaced southward 5°–10° of latitude, presumably as a consequence of high-latitude blocking and the resultant depression of the westerlies.

Referring again to figure 9, other areas of above normal precipitation are shown in California, where Mt. Shasta had the wettest January since 1916. There was a secondary streak from northern Texas to South Carolina. The large area which had less than 50 percent of normal precipitation included Dallas, Tex., which reported the driest January of record, and Albuquerque, N. Mex. which reported its sunniest. Dry weather in this area was related to northwesterly flow aloft south of the principal storm track.

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